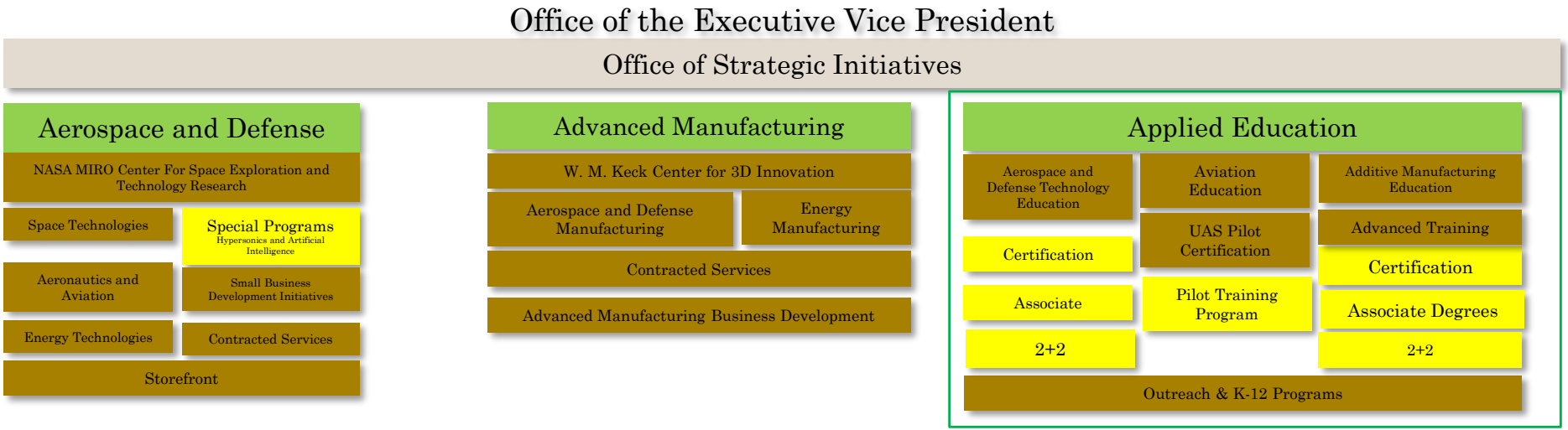
Office of the Executive Vice President
The University of Texas at El Paso

Regional Capacity and Talent Development

Aerospace & Defense | Advanced Manufacturing

Ahsan Choudhuri, PhD
Associate Vice President for Strategic Initiatives

Aerospace and Defense Capabilities

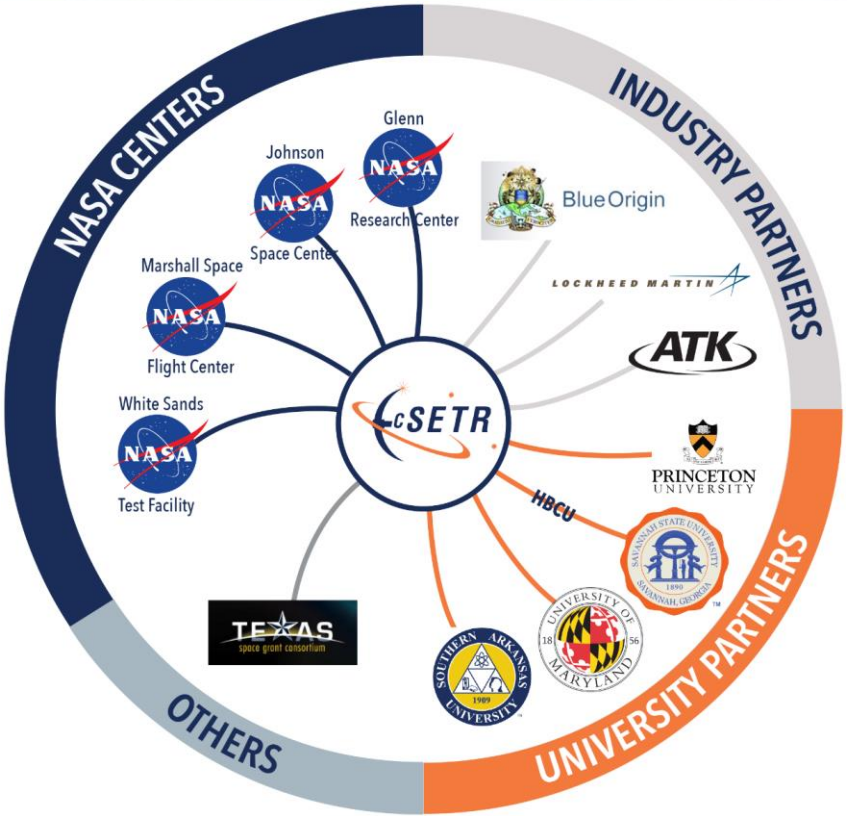


NASA MIRO University Research Center

Center for Space Exploration & Technology Research

The University of Texas at El Paso

MIRO cSETR External Partners



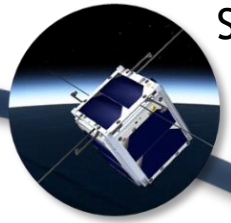
cSETR Facilities

MIRO cSETR On-Campus Facilities

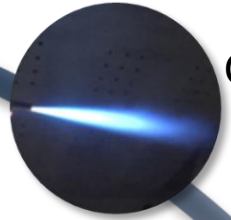
cSETR Facilities

Secured Facility

Spacecraft Design and Engineering Facility



Goddard Facility

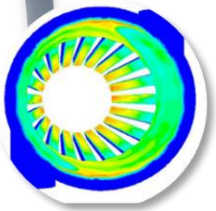


Unmanned Aerial Vehicle Systems Laboratory

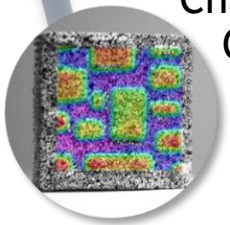
cSETR Office Complex

Aerospace Education Lab

Computational Lab



Challenger-Columbia Facility



MIRO cSETR On-Campus Facilities

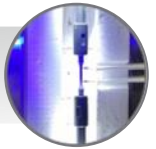
Research Capabilities

Goddard Research Facility

Combustion and Propulsion

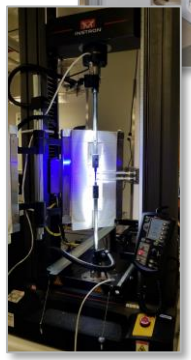
- Bunker and Control Room
- Projectile Proof
  - 600ft2 Test Area
  - Camera Accessible
  - Remote Control Operation
  - Sea Level Operation
- High Speed Imaging
- Flame Studies Capability
- Emissions Analyzers
- Adaptable Exhaust System
- Planetary/Shaker/Roller Ball Mill

Challenger- Columbia Research Facility



Materials Processing and Characterization

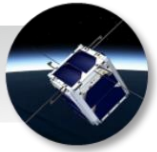
- Multiple High Temperature Furnaces
- Nano-Indentation System
- Vacuum Ovens
- Composite fabrication
- Material Testing Systems
  - For tension, compression and flexural testing
    - Instron Corporation, Model 5866, with 10kN and 0.5kN load cells
  - For static and dynamic testing including durability, fatigue crack growth, high and low cycle fatigue, fracture toughness, tension, compression
    - MTS Systems Corporation, Model 370 servohydraulic system, with 100kN load cell
  - For static and dynamic testing including durability, fatigue crack growth, high and low cycle fatigue, fracture toughness, tension, compression
    - MTS Corporation, Model 370.02 Axial-torsional servohydraulic system, with 25kN load cell, 200N-m torque rating



MIRO cSETR On-Campus Facilities

Research Capabilities

Spacecraft Design and Engineering Facility



Environmental Testing Equipment

- Vibration testing up to Max.11G, 40 lb. load testing Random, Sine force, & Shock
- Vacuum chamber at 1.4 10-6 torr & 5 thermocouples (K-type)

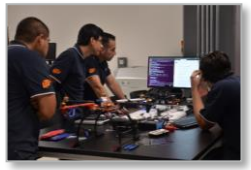
Electronics

- Cadence OrCAD Allegro Schematic/PCB Layout Software Suite
- SMTMax QM1500 Pick and Place Machine
- SMTMax AE-F600C ReFlow Oven
- NI USRP Software Defined Radio Device packages: ethernet enabled, real-time software controlled
- Schematic Capture, SPICE, and PCB Design Software
- Laser microwelder (Miyachi LW5AG)

Student Collaborative Area

Unmanned Aerial Vehicle Systems Laboratory

- Unmanned Traffic Management (UTM) systems
- (28) Autonomous Long Range/Long Endurance aircrafts, both fixed and rotary wing
- Autonomous SLAM aircraft able to navigate in confined GPS-denied environments
- Advanced Sensors and applications, to include: EO, Multispectral, IR, UV
- Advanced post-processing capability to produce a range of research-grade data products
- UAV Ground and flight academics



MIRO cSETR On-Campus Facilities

Research Capabilities

Computational Laboratory

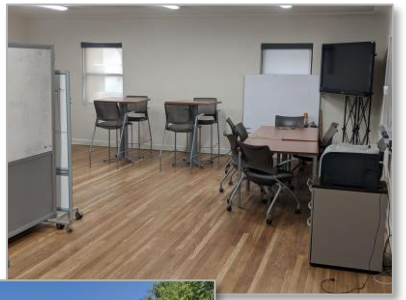
Computational Work

- (12) Desktops
- Securely controlled servers and storage array
- Software available:
  - Abacus
  - ANSYS Workbench
  - Fluent
  - Matlab
  - Mathematica
  - HyperWorks
  - ASPEN One
  - CAD (NX 10, Solidworks, CREO)

cSETR Office Complex

Student Office Space

- Seats 30 students
- (4) White boards
- (2) Mobile white boards
- (2) Conference Rooms
- Seats 6 people each
- General office supplies
  - Rulers, staplers, dry-erase markers, etc.
- Kitchen area with appliances
  - Refrigerator
  - Coffee machine
  - Oven
  - Microwave

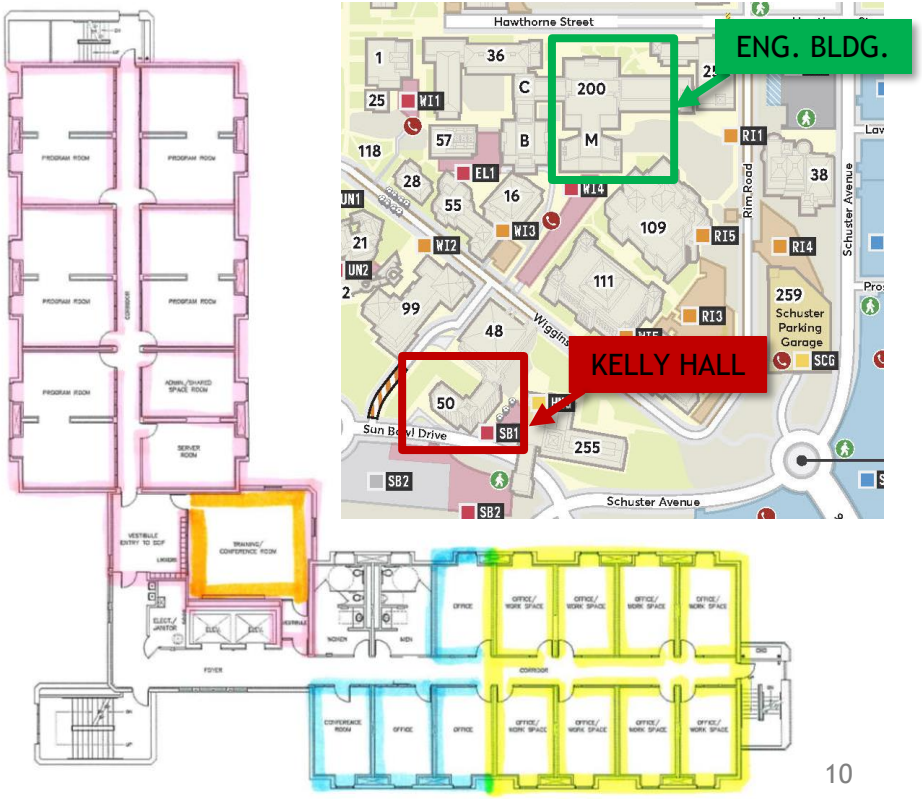


MIRO cSETR On-Campus Facilities

Research Capabilities

Secure Research Facility | *Under Construction*

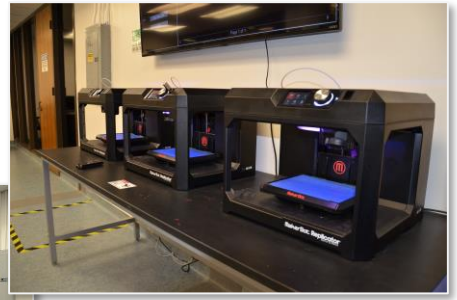
- High Security Area (ICD 705) | ~4,000 sf
  - 5 separate program spaces* | ~430 sf each
  - Data Center/Server Room* | ~170 sf
  - Admin Room* | ~170 sf
  - Training/Conference Room* | ~450 sf
  - Vestibule/security desk
    - In addition to the security perimeter (pink), each space is built to accommodate a separate program IAW ICD 705 standards. Each space is linked to the data center by secure conduit.
- 8 Collateral work spaces | 200 sf each
- FSO & security admin spaces | ~800 sf



Facilities Available to NASA MIRO cSETR

Design Studio I: 3-D Printing

- 3-D Printing machines
  - MakerBot Replicators, uPrint
- Assembly area

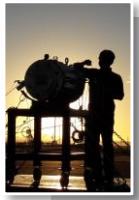


Design Studio II: Machine Shop

- **Studio Area**
  - Design Stations with 38” displays
    - NX 7.5, Solidworks, Pro-E and CATIA
  - Project Presentation Facility
  - Team Meeting Room
  - FMD 3D Printer
  - HP DesignJet Plotter
  - Bench-top Workstations

- **Machine Shop Area**
  - CNC: Mill & Lathe
  - Conventional: Mill & Lathe
  - Tig & Mig Welder
  - Vertical / Horizontal saw
  - Grinding Stations

MIRO cSETR Off-Campus Facilities



tRIAc - Alpha Site

- Research & Development
- Control Center
- Test Cells
- Vertical Test Stand

Fabens, TX

tRIAc - HQ Site

- Design studio & Manufacturing Workshop
- Fabrication and Integration Shop
- Collaboration Common: Graduate, Undergraduate, & K-12

Fabens, TX

Tornillo Unmanned Aerial System Flight Test Range

- 20-25 acres facility + Flight Test Range (600 acres)
- 400-ft Runway
- Test Support Facility (planned)

Fabens, TX

tRIAc - Aeronautics Research and Learning Facility (Planned)

- Flight Wind-Tunnel Research and Education Complex
- Subsonic Wind Tunnel
- Water Tunnel Supersonic Tunnel

Fabens, TX

Fabens General Aviation Airport

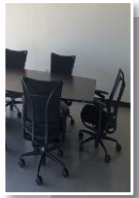
- *Partner Facility*
  - Managed by El Paso County
- 4,200 ft. & 2,300 ft. Runways
- 400 acres

Fabens, TX

Francis Facility

- Instructional & Training Facility
- Satellite Ground Station (underdevelopment)
  - 2.4 m S-band antenna | 436 MHz UHF antenna

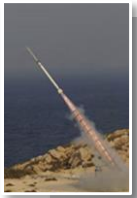
El Paso, TX



Horizon City Aerospace and Defense Accelerator

- *Partner Facility*
  - Horizon City Economic Development Corporation
- Small Business Incubator

Horizon, TX

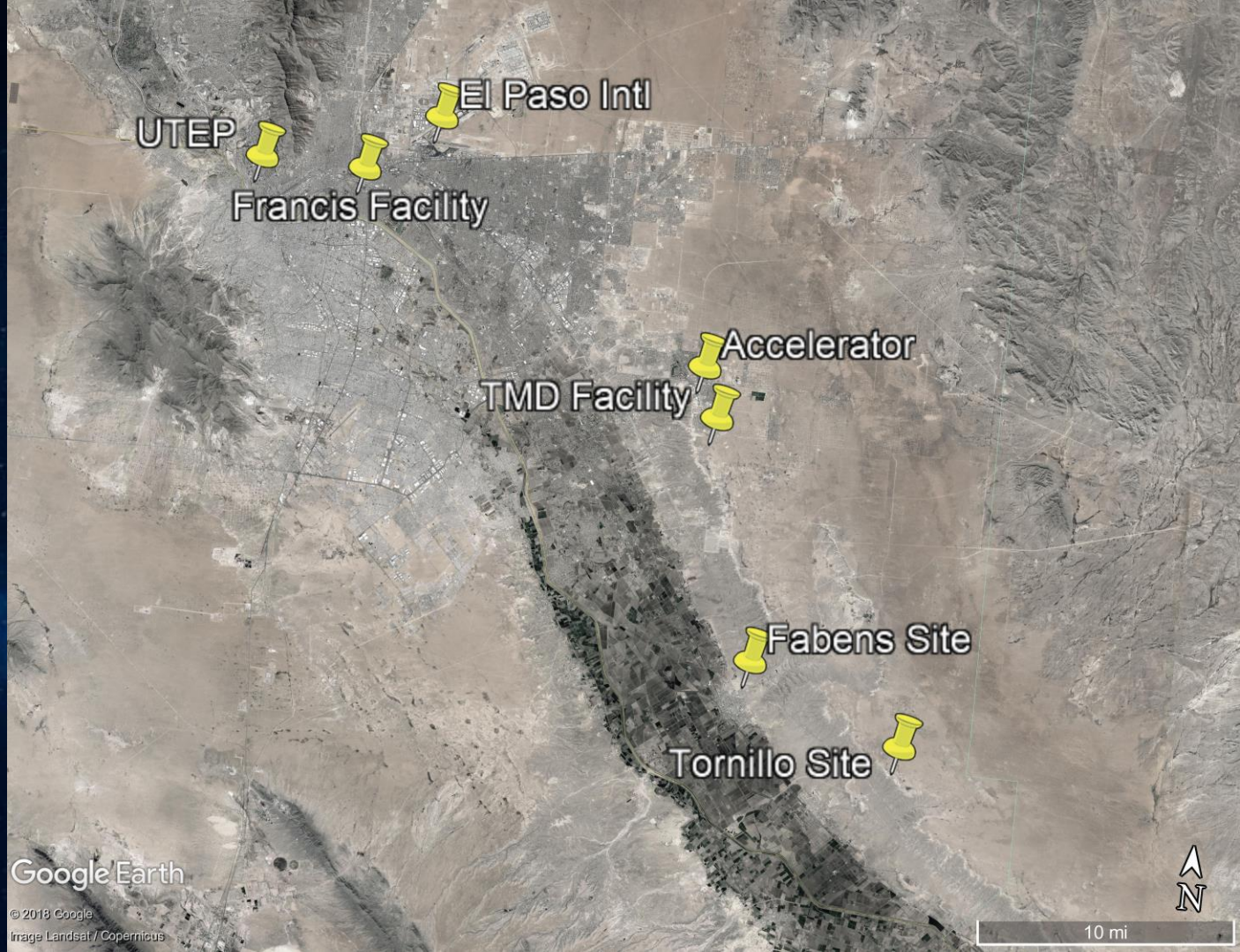


TMD Defense and Space

- *Partner Facility*
- Administrative Area & 21,000 sf warehouse, Hazardous Material Assembly Area with (10) Missile Assembly Cells & (7) Storage Magazines & Firefighting Support Building

Horizon, TX

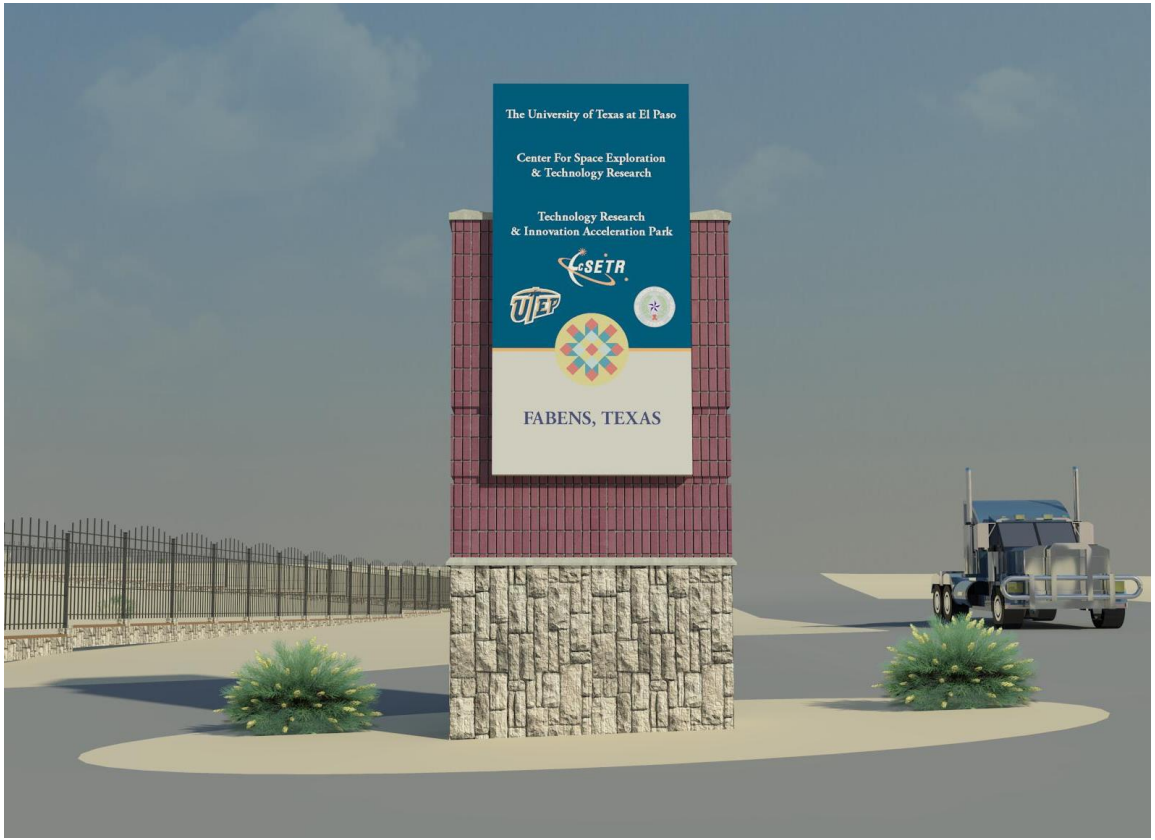
MIRO cSETR Off-Campus Facilities



Technology Research & Innovation Acceleration Park

(tRIAc Park)

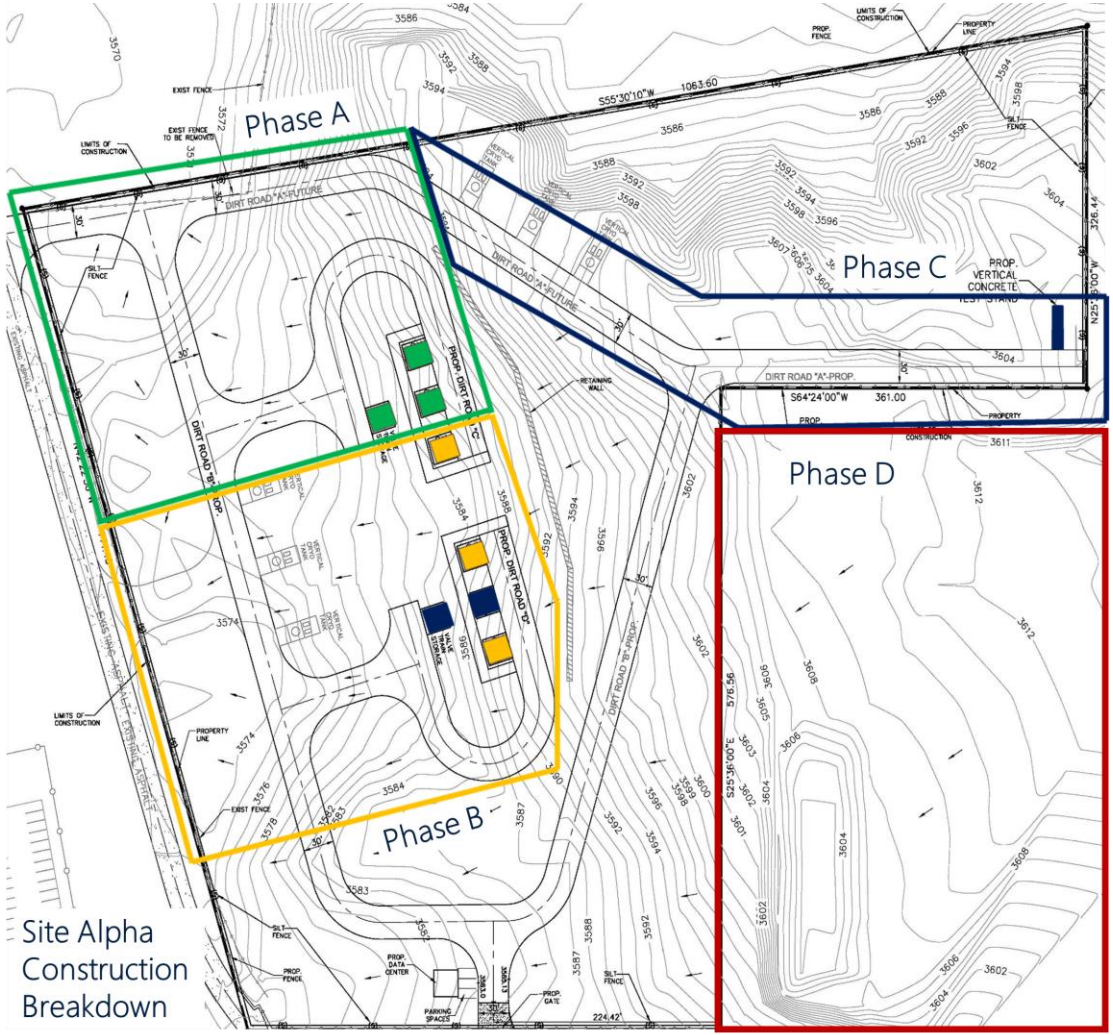
Fabens, Texas



tRIAc Park

Alpha Site

- Phase A – Complete
  - Access Road
  - Electrical Services
  - 3 Test Cells
- Phase B
- Access Road
  - Electrical Services
  - 2 Test Cells
  - Vertical Test Stand
- Phase C
  - Access Road
  - 2 Test Cells
  - Vertical Test Stand
- Phase D
  - Aeronautics Research and Learning Facility



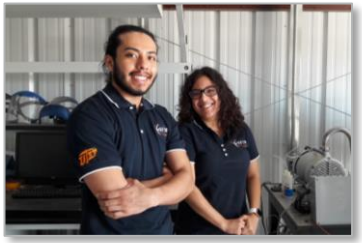
tRIAc Park
Alpha Site

- Testing Facility
  - Size:
    - Phase 1: 3 Acres
    - Total: 18 acres
  - Test Cell Maximum Static Load
    - 13,000 lbs.
  - Electrical
    - Site: 480V/3phase
    - Test Cell: 220V/3phase

tRIAc Park

HQ Site

- Manufacturing and Integration Facility
- Size
  - Indoor: 10,800 ft^2
  - Total: 3.92 acres
- Electrical Service
  - 200 AMP/240V



Courtesy of JR Hernandez

Courtesy of JR Hernandez

Tornillo Unmanned Aerial System Flight Test Range

- **Facility Designated for Unmanned Aerial System Flight Testing**
- Location: Tornillo, TX | 38 Miles from UTEP main campus
- Size:
  - 20-25 acres facility
  - Flight Test Range (600 acres)

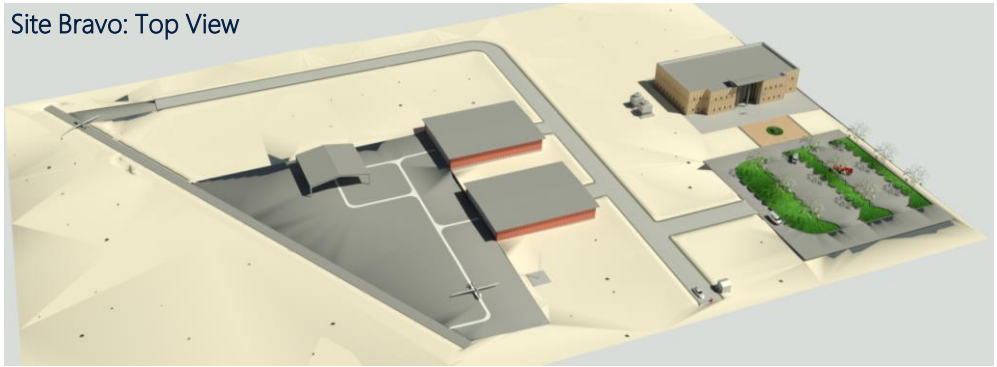
Site Bravo:
Facility Offices

Phase A – Dirt work and Signage

- Rock in access road
- Level Site Bravo area
- Establish entry sign at current gate entrance
- 300’ x 20’ Runway
- Storage facility
- Gravel parking lot

Phase B – Facilities & Paved Access

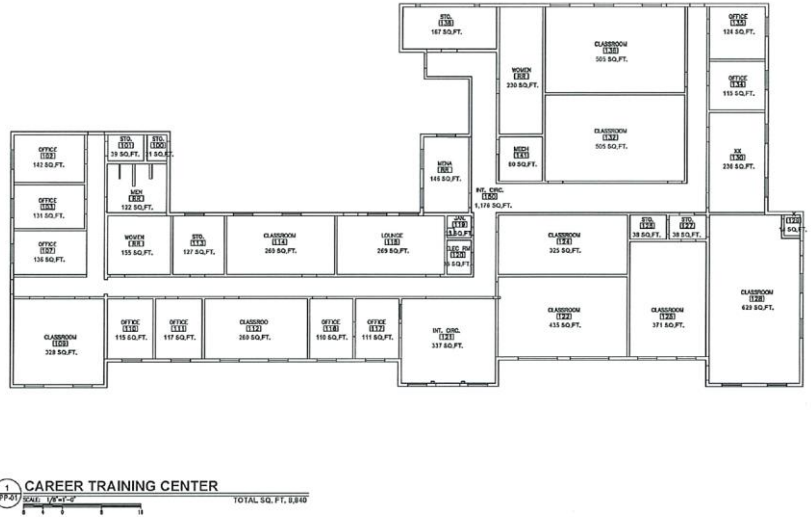
- Pave 500’ x 20’ Runway
- Facility Offices
- Paved Roads



Site Bravo: Top View

Francis Facility

- Instructional & Training Facility
  - Size: 9,000 sf
  - 20 parking spaces
- Satellite Ground Station (underdevelopment)
  - 2.4 m S-band antenna | 436 MHz UHF antenna



Partner Facilities

Fabens General Aviation Airport

- Managed by the County of El Paso
- 4,200 ft. & 2,300 ft. Runways
- 400 acres

Horizon City Economic Development Accelerator

- Capabilities
  - 2400 ft^2 of Space
  - 3 Cubicles for small businesses
  - Soon to be expanded to 6 Cubicles
  - Conference Area
- Subsidized office space for small business growth.

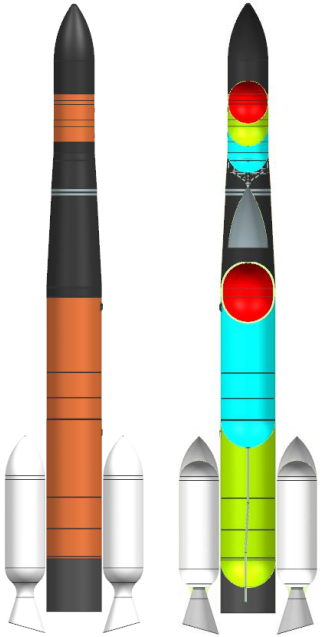
Partner Facility

TMD – Horizon Facility

- Capability
  - Administrative Areas
    - Conference Room
    - Kitchen / Break Room
  - Warehouse
    - 21,000 sf
    - 20ft clear ceiling height
  - Hazardous Material Assembly
    - (10) Missile Assembly Cells
    - (2) Loading bays with Drive-in Doors
  - Munitions Storage Magazine
    - (7) Storage magazines (1,650 sf each)
  - Firefighting Support Building
    - 250, 000 gall water storage
    - 2,000 gal/min pump capacity
  - Change Building
    - Dressing area, Lockers, & Showers

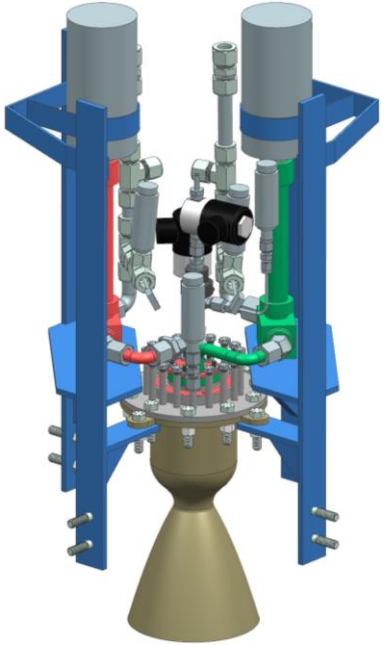
cSETR Aerospace Technical Goals

…a bold research agenda

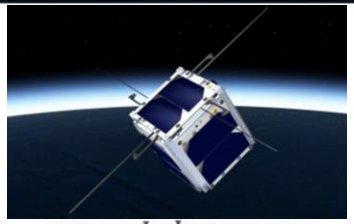


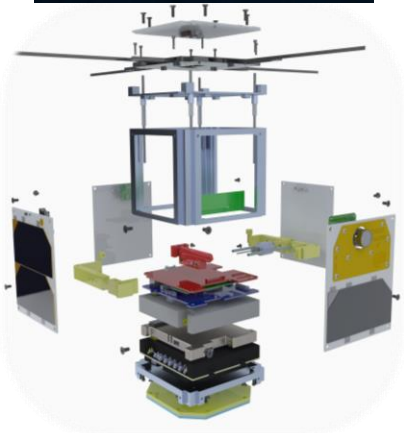
CSpLV
Centennial Small Payload Launch Vehicle

HypTest
Hypersonic Test Vehicle



Janus
Robotic Lunar Lander





Orbital Factory
SmallSat On-Orbit Manufacturing

cSETR Aerospace Technology Roadmap

LO_2/Methane
[Space Technology]


Regen Cooling Channel


Torch Igniter


CROME 500 lb_f


5 lb_f RCS


CROME-X 2000-4000 lb_f


DAEDALUS
Suborbital Payload Scale Methane Propulsion Technology Testbed


JANUS
Robotic Lander Scale Methane Propulsion Technology Testbed


CSLV
Centennial Small Payload Launch Vehicle

Green Propellant
[Space Technology]

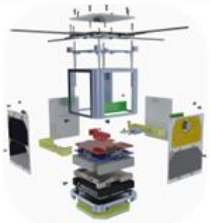

Propellant Fundamental Study


0.224 lb_f


5 lb_f


SmallSat Propulsion Module

SmallSat
[Space Technology & Science]


Orbital Factory II


NASA WSTF Cold Gas Module


Orbital Factory III


Orbital Factory X

Unmanned Aerial Systems
[Aeronautics]


Unmanned Traffic Management


UAS Research and Training


Beyond Visual Line of Sight Operation

Contact Information

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  El Paso, TX 79968-0521

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  Email: csetr@utep.edu

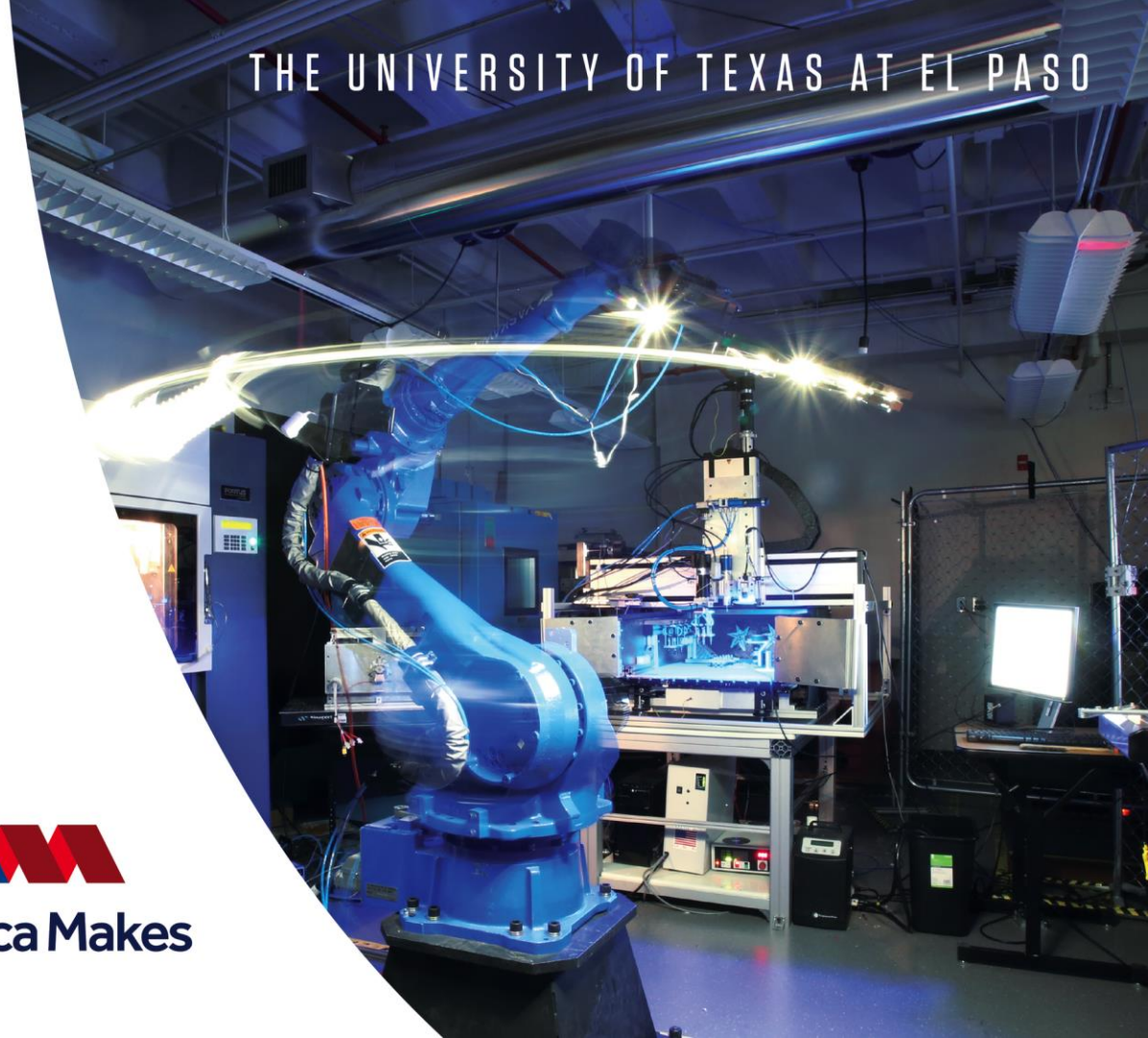
  facebook.com/MIROcSETR

  twitter.com/UTEP_cSETR

W.M. Keck Center for 3D Innovation

Research Capabilities

December 2018



W.M. KECK CENTER
FOR 3D INNOVATION

America Makes

W.M. Keck Center for 3D Innovation

- Founded in 2000 - 13,000 sq ft facility with 50+ additive manufacturing (AM) machines
- Expanding to 17,000 sq ft facility in downtown El Paso (large area AM, training, economic
- R&D projects with more than 100 industrial clients and 10 federal agencies
- Broad and expanding patent portfolio
- Students becoming leaders in AM industry – workforce development pipeline
- Economic development initiative – creation of regional AM-based businesses
- Selected as America Makes Satellite Center in 2015

W.M. KECK CENTER
FOR 3D INNOVATION

America Makes
National Additive Manufacturing Innovation Institute

Equipment/Capabilities Snapshot

- **30,000 sq ft on and off campus facilities** (AM and hybrid AM – polymers, metals, ceramics, electronics, composites; materials synthesis and characterization; metrology, microscopy and mechanical testing; cell culture; training; economic development)
- **Industrial AM Systems:** Cincinnati BAAM; Fortus 900, 400(s); SLA 500, Viper(s); ExOne M-Flex; Laser PBF (AconityOne, SLM 125, EOS M290); Electron Beam PBF (Arcam A2 and high temp S12)
- **Hybrid AM Systems:** Robotic handling; Tool exchange; BAAM; Desktop(s)
- **Experimental AM Systems:** ExOne X1-Lab; Zprinter 450(s); Multi-material SL; micro-SL; many desktops
- **Suite of Mechanical Testing and Polymers/Metals/Ceramics Characterization Instrumentation and Equipment**

Keck Center - Driving the Additive Manufacturing Revolution

Research and Technology Development

- Polymers, metals, ceramics, composites, electronics AM
- Hybrid AM, large area AM, automation, robotics
- Multi-functional applications

Industry and Government Partnerships

- AM, CAD, and testing service center
- Value added expert AM solution providers

Education, Training and Workforce Development

- Graduate 3D engineering and AM certificate program
- Point-of-need basic, expert, and custom AM training
- Workforce development pipeline program

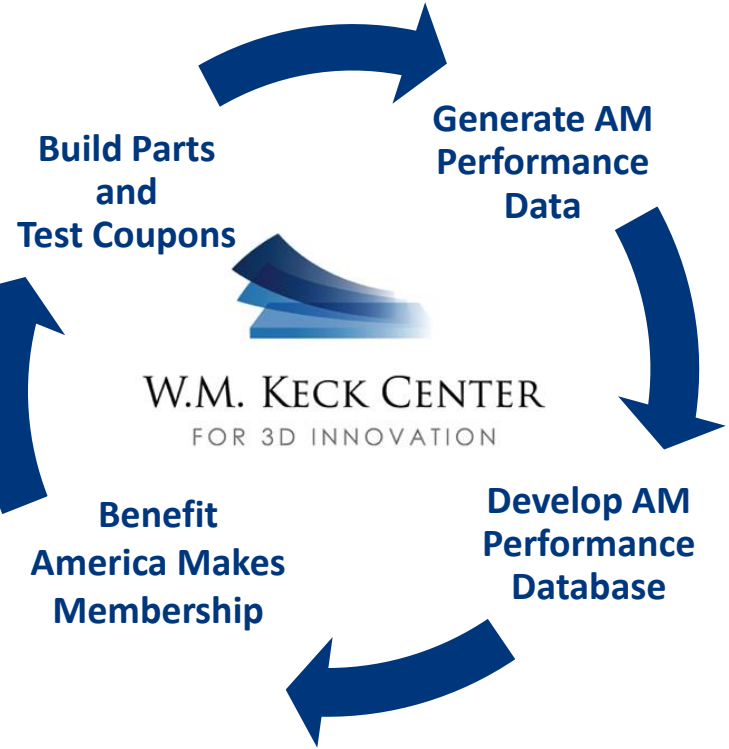
Economic Development

- Creating technology spin-off companies
- Recruiting AM companies to El Paso

America Makes
National Additive Manufacturing Innovation Institute

Enhancing Member Benefits through New America Makes Model

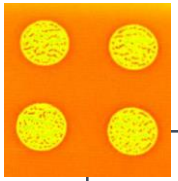
Over 218 America Makes Members



New Enhanced Benefits

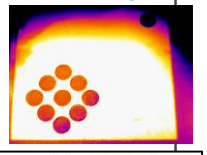
- Fees/Cost Share for membership
- Certified testing
- OEM equipment and materials partnerships
- AM database
- Advanced workforce
- Economic development

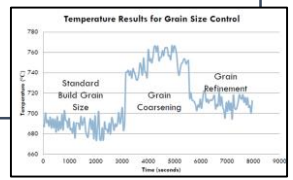
Technical Research Areas

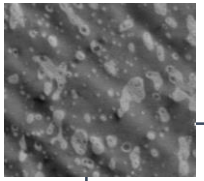


In-situ monitoring and control

- IR imaging, pyrometry
- Layerwise fabrication control
- Defect detection and correction
- Microstructure control and tailoring

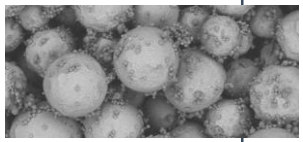


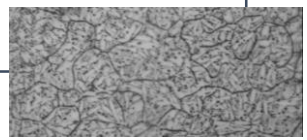


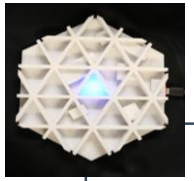


AM-enabled materials

- Multiple material fabrication
- Polymers, metals, ceramics, composites, electronics
- Mechanical testing and materials characterization

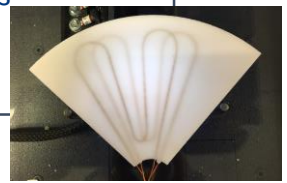






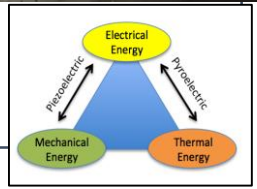
Hybrid manufacturing, stop-n-go manufacturing

- 3D electronics
- Embedded sensors
- Reinforcement
- Design software
- Artificial intelligence
- Machine development
- Large area AM
- Robotics

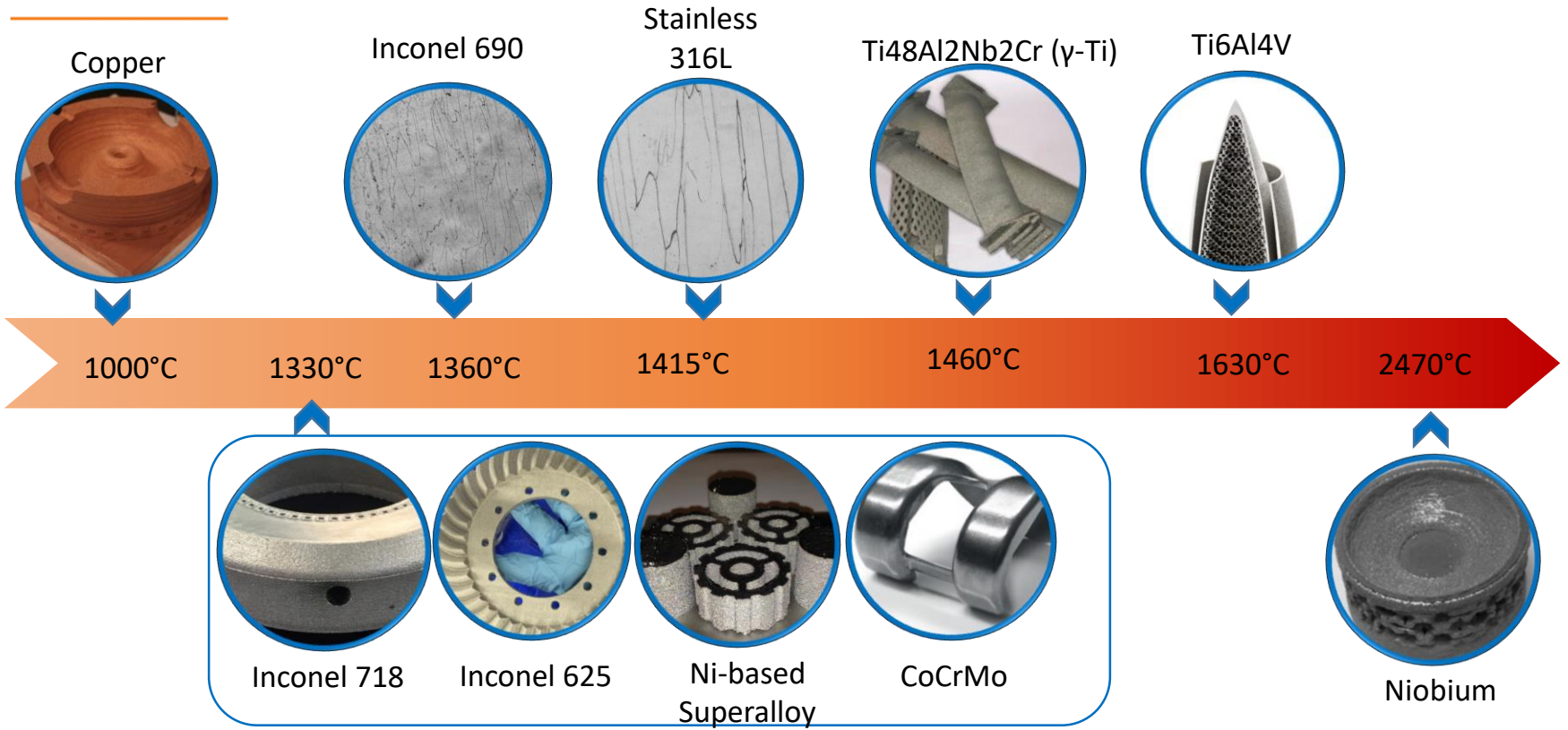


Ceramics and sensors

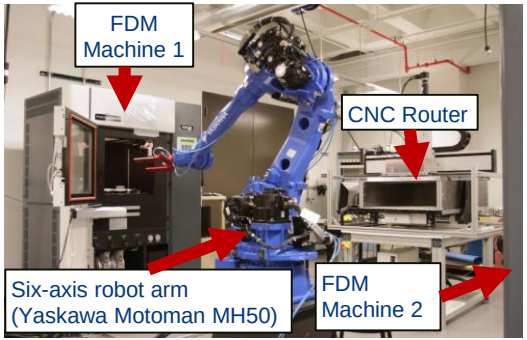
- Piezoelectric materials
- High temperature materials
- Sensors



AM Metal Materials Expertise



Multi3D Demonstrations

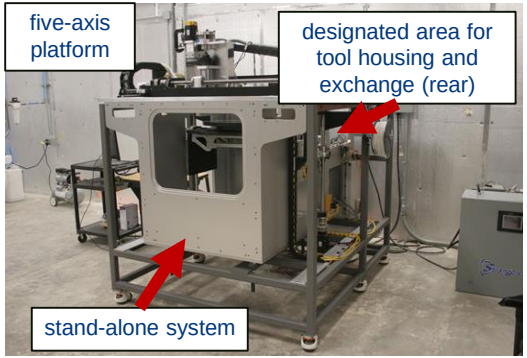


Robot Multi3D System Capabilities:

- Material extrusion (filament)
- Thermal wire embedding
- Foil embedding
- Direct-write
- Robotic component placement
- Machining
- Robot material handling

Tool Exchange Multi3D Capabilities:

- Filament Extrusion
- Pellet Extrusion
- Machining
- Wire Embedding
- Foil Application
- Pick-and-place
- Machine Vision

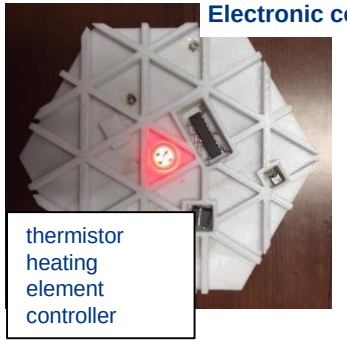


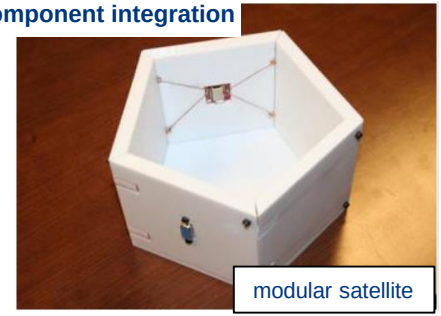

printed missile seeker

Eliminates labor-intensive fabrication

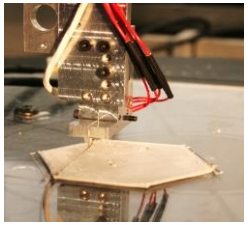
82 part transfers

Electronic component integration


thermistor heating element controller


modular satellite

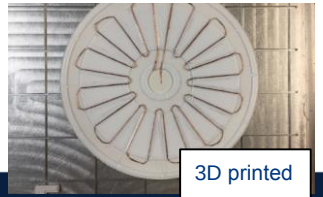
Wire Embedding Tool



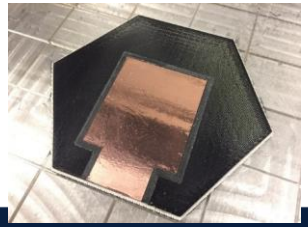
Pick-and-Place Tool

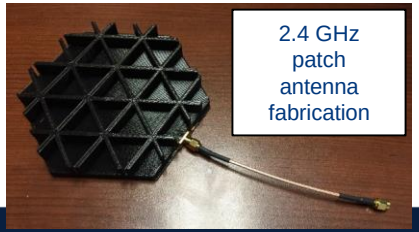
Wire embedding for axial motor stator fabrication


conventional


3D printed

Machining and foil application for antenna fabrication





Big Area Additive Manufacturing (BAAM)

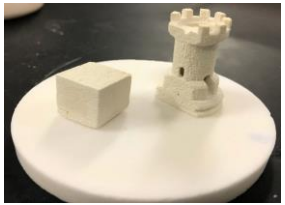
- Material is typically reinforced with carbon or glass fibers to mitigate warping and distortion
- Single-screw extruder
- Platform is equipped with heating elements
- Build envelope: 3.5 x 1.6 x 1.8 m
  (140” x 65” x 72”)

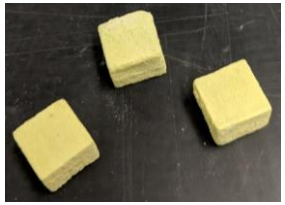
	medium thermoplastic material extrusion	large thermoplastic material extrusion
build volume	0.03 – 0.3 m^3	25 m^3
deposition rates	0.015 - 0.082 kg/ h	up to 50 kg/h
build material cost	$100 – 200 per kg	$2 – 10 per kg

CINCINNATI®

UTEP’s Cincinnati BAAM machine

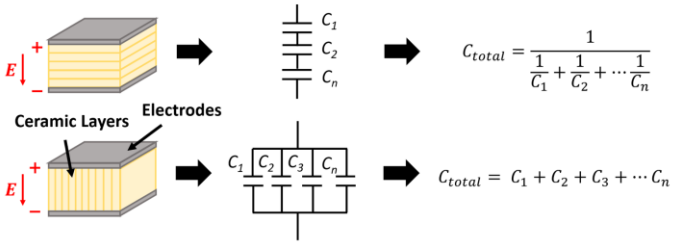
Functional Ceramic Printing

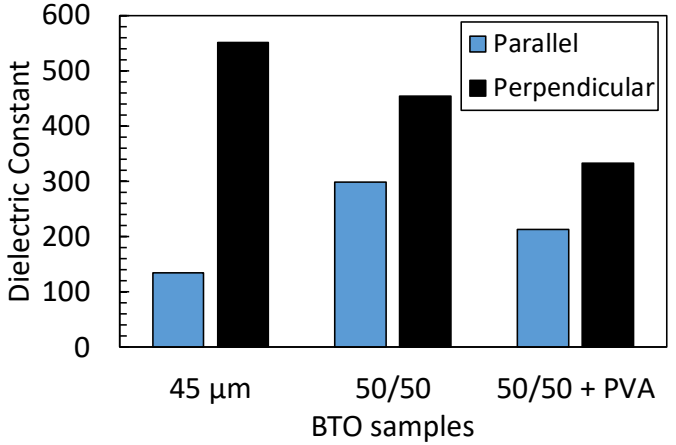




- Binder jetting focused, but also exploring material extrusion and vat photopolymerization
- Piezoelectric (PZT and BaTiO3) and high thermal conductivity (AlN) ceramics – current interest
- Increasing density and functionality using various process optimization and post processing techniques

Directional Properties





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